

# Handling OOV Words In Arabic ASR Via Flexible Morphological Constraints

Nguyen Bach, Mohamed Noamany, Ian Lane, and Tanja Schultz



## Overview

One key problem in ASR is the detection and recognition of out-of-vocabulary (OOV) words. We propose a novel framework where OOV-words are detected by applying a hybrid language model (HLM) during ASR. Recognition of OOV-words is performed using a combination of three methods: dictionary look-up, morphological composition, and direct phoneme-to-grapheme conversion.

## Motivation

- OOV words often contain key information and are vital to realize effective information extraction and retrieval of multimedia data.
- OOV words recognition errors induce errors in neighboring words.

## Problem

- Explicitly modeling OOV words during ASR as a sequence of subword models depends heavily on accuracy of phone recognizers.
- Correcting ASR errors using offline monolingual corpora heavily relies on confident scores, and minimal errors in 1-best ASR hypothesis.

## Proposed Framework

Apply a HLM during ASR. OOV words expressed as a sequence of subwords units.

Conv. LM	Ely <b>AlmqAs</b> AlAmryky
HLM	Ely <b>[A] [l] [m] [q] [A] [s]</b> AlAmryky

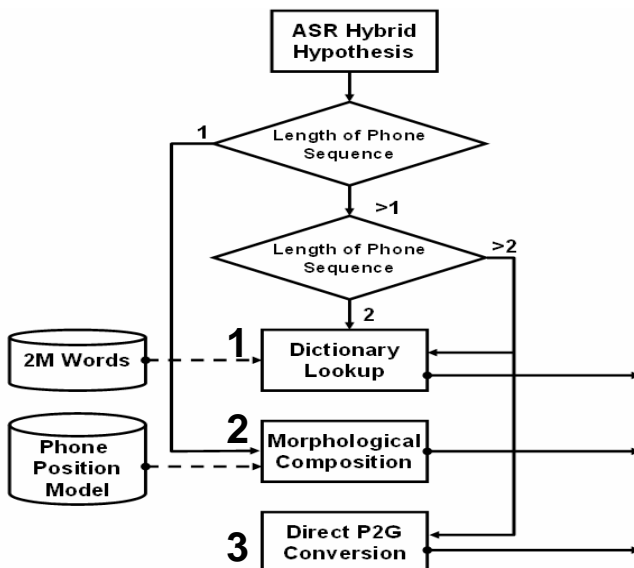
OOV words recognized via a flexible back-off scheme. External knowledge sources apply an increasingly weaker constraints.

## System Overview

Perform ASR decoding to obtain the 1-best hybrid hypothesis.

Reference	... bMnh <b>syHAKm</b> gyAbyA ...
Baseline	... bMnh <b>syHASb</b> gyAbyp ...
Hybrid Hyp.	... bMnh <b>[s] [y] [H] [A] [k] [m]</b> gyAbyA ...

If phone sequence detected in the ASR hypothesis we use three different methods applied to recognize OOV words.



### 1. Dictionary Lookup

If  $\text{length}(\text{phone sequence}) > 1$ , convert sequence into a word via P2G, retain OOV-word hypothesis if contained in very large (2M entries) dictionary, discard otherwise.

Reference: ... bMnh **syHAKm** gyAbyA ...  
 Baseline: ... bMnh **syHASb** gyAbyp ...  
 Proposed Approach: ... bMnh **[s] [y] [H] [A] [k] [m]** gyAbyA ...  
 bMnh **syHAKm** gyAbyA

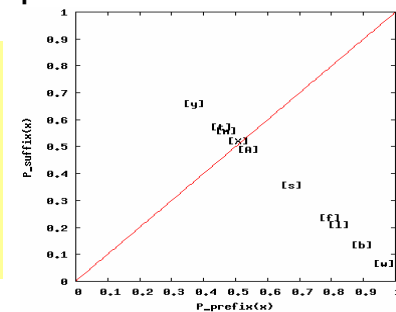
### 3. Direct Phoneme-to-Grapheme Conversion (P2G)

If  $\text{length}(\text{phone sequence}) > 2$ , convert the sequence into a word.

## 2. Morphological Composition

OOV words could be morphological variants of entry within recognition vocabulary.

Compose OOV-word by appending phone to neighboring words.



If  $P_{\text{prefix}}(x) > \delta$ , append phone to the following word, else if  $P_{\text{suffix}}(x) > \gamma$  else discard where  $x$  is a phone sequence with length = 1.

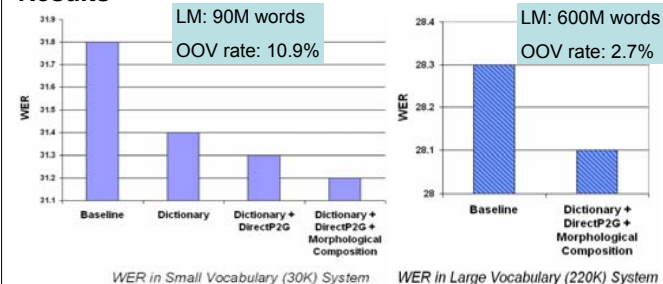
Reference: ... AlmTArAt **wmdrjAt** AlhbwT ...

Baseline: ... AlmTArAt **wmdrkp** AlhbwT ...

Proposed Approach: ... AlmTArAt **[w] mdrjAt** AlhbwT ...

AlmTArAt **wmdrjAt** AlhbwT

## Results



- Significant reduction in WER, 5% truly novel OOV words recognized (large system), recognition accuracy in neighboring words improved.

## Conclusion

- Proposed a novel framework for OOV word detection and recognition in Arabic ASR.
- Extended the HLM to estimate OOV words via subword units, and incorporated three methods to recognize OOV words via morphological constraints.